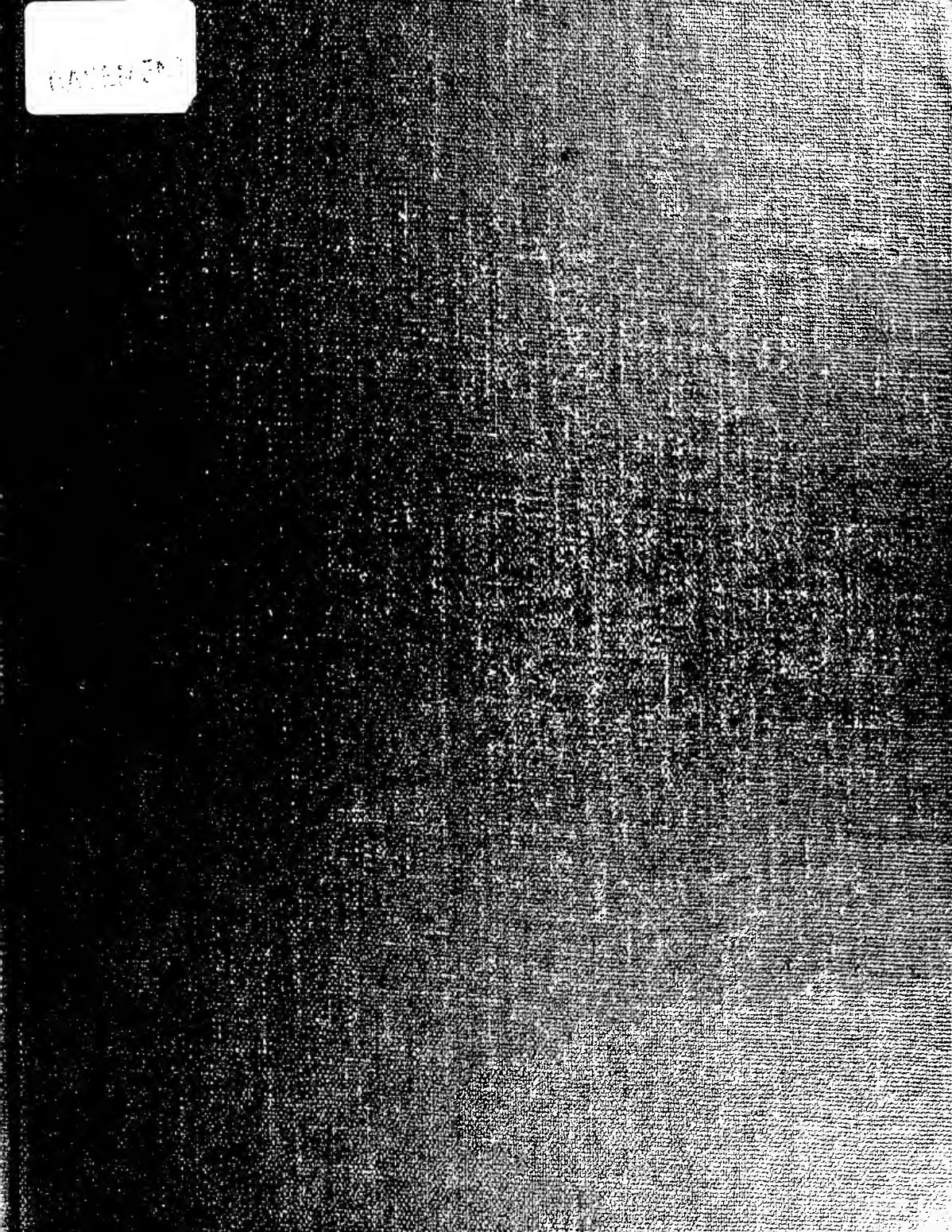

ANALYZING CONSUMER RESPONSE TO INNOVATION: THE CONCEPT OF PREFERENCE INERTIA

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Abstract

This research introduces the concept of preference inertia as a tool for understanding consumer response to innovations. This concept postulates that consumers may hesitate in preferring innovations over an existing product even though the innovations elicit superior evaluations. Preference inertia is examined within the context of the actual development of a Health Maintenance Organization (HMO). The manifestation of preference inertia by the HMO's potential enrollee population is explained using general attitude and demographic factors. The concept is then included in a linear attitude model of consumer response. Results and implications are discussed.

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I wish to thank Professors Glen L. Urban of MIT and John R. Hauser of Northwestern University for invaluable advice concerning this research. The ideas and guidance of Professor Urban were instrumental in achieving the results of this research. His editorial support was significant in clarifying issues of exposition. Discussions with Professor Hauser before this research was executed were important in defining and modeling the concept of preference inertia.

INTRODUCTION

Linear attitude models have been studied extensively as a means of understanding consumer response to products and services. These models explain preference or choice in terms of consumers' perceptions of product attributes [1,2,3,4,5,7,9,14,21,24,25]. Since these perceptions change as the design of the product is altered, such models provide an invaluable link between product design and consumer response.

Behavioral phenomena such as adherance to group norms or innovativeness are not always incorporated in linear attitude models, although there are some examples in the literature [6,10,20,22]. One reason for this might be that such phenomena are not easily influenced and hence are not decision variables for product designers. Another reason is that behavioral variables have not always been successful in predicting consumer behavior [8,10].

The above reasoning may seem to indicate that analysts should concentrate exclusively on product attributes in developing consumer response models. However, in any particular situation, a behavioral phenomenon may be so influential in determining consumer response that it is advantageous to explicitly consider that phenomenon. This paper will examine one such instance; the event that consumers do not prefer a new innovation to an existing product although the innovation is evaluated higher than the existing in terms of product attributes. We shall refer to this hesitancy or even obstinacy on the part of consumers as "preference inertia". This research will examine preference inertia in order to explain and understand it, and then incorporate it into a linear attitude model of consumer response. The results will be enhanced understanding of the consumer response process, richer design diagnostics, and increased precision in prediction.

THE PROBLEM

The concept of preference inertia grew from the experience of trying to predict consumer response to various Health Maintenance Organization (HMO) designs. HMO's have attracted widespread interest in the health field recently. They provide comprehensive medical services to enrollees who pay a fixed monthly premium. It was found that linear prediction models were systematically under-predicting consumer preferences for staying with the existing pattern of care versus a new HMO plan. It appeared that consumers evaluated various new comprehensive health plans quite highly, yet refrained from preferring these innovations to their present care.

In particular, the study we are concerned with involved the design of an HMO for the Massachusetts Institute of Technology (MIT) community, consisting of students, staff, and faculty. Respondents, as part of a questionnaire survey, were presented one-page descriptions of three new health plans; the Harvard Community Health Plan (HCHP), the MIT HMO, and the Massachusetts Health Foundation (MHF). They were then asked to rank order according to preference the three new plans along with their existing health services. In addition, respondents evaluated each of the four health plans along a set of 16 attitude scales. These scales were reduced to four underlying perceptual dimensions using factor analysis techniques. The dimensions uncovered were labeled "Quality", "Personalness", "Value", and "Convenience". Factor scores for each individual, for each plan, along each dimension could then be related to rank order preference (see [12] for a more detailed description of this research, and [11] for a detailed explanation of the methodology used).

Preference was predicted using various models. These models related preference

to a weighted combination of factor scores for the four dimensions. Since each respondent evaluated four health plans, there were four observations per respondent of preference ranking vs. factor scores for quality, personalness, value, and convenience. Appropriate weights were derived using ordinary least squares regression and monotone regression. A third model used unit weights so that an equal weights model could be evaluated. A multiplicative model was calibrated using regression to test the importance of the linearity assumption. To obtain a preference prediction for a particular individual, the respondent's factor scores were combined using the weights, resulting in a scaler measure of evaluation for each plan. The plan with the highest measure was predicted as being the respondent's first preference, the second highest as second preference, and the lowest as last preference. This was done for each individual in the sample. Finally, the prediction results for each model were summarized in a 4x4 "recovery" matrix of predicted preference versus actual preference. The number in the i-th row, j-th column (a_{ij}), represented the number of times over the entire sample we predicted a health plan would be preferred i-th though it was actually preferred j-th. First preference recovery is thus $a_{11}/\sum_i a_{ij}$ (note $\sum_i a_{ij} = \sum_j a_{ij}$) and diagonal recovery is $\sum_i \sum_{j=i} a_{ij}/\Sigma\Sigma a_{ij}$.

Table I presents prediction results, which were fairly good. All recovery matrices were significantly different from random prediction. The use of statistically derived weights or equal unit weights resulted in little difference in prediction. This is consistent with past studies [5,9,21,24]. The important phenomenon to notice is that existing care preference share is consistently under-predicted by an average of 15 percentage points. In addition, we note that HCHP and MHF shares are consistently over-predicted, while MIT share is fairly well recovered. The surprising fact is that this lack of fit is so consistent

across various modeling techniques.

TABLE I

INITIAL PREDICTION RESULTS

Method	1st pref. Recovery	Diagonal Recovery	Preference Share E	HCHP	MIT	MHF
Linear regression	48%	44%	26%	15%	26%	33%
Non-linear regression	50	46	26	15	27	33
Monotone regression	52	47	28	15	26	32
Unit weights on 4 dimensions	46	45	27	14	27	32
Actual	-	-	43	10	26	20

The concept of preference inertia was articulated from this information. It was hypothesized that for reasons external to the perception of product attributes, consumers exhibit a certain conservativeness or even obstinacy in switching their preferences to a new innovation. This behavior was thus labeled preference inertia, and was visualized as being essentially a predispositional factor that could be explained using demographic, behavioral, and general attitudinal variables.

ANALYSIS

Our analysis of preference inertia encompasses three basic tasks; segmentation, measurement, and testing. In the segmentation phase, the respondent group was divided according to their tendency to exhibit preference inertia. Demographic, behavioral, and general attitudinal differences between these groups were investigated in order to understand and explain the phenomenon. Measurement involved the incorporation of preference inertia into linear models of consumer response. Testing then involved evaluating these models.

Segmentation;

As a measure of a respondent's evaluation of a given health plan, we used the unweighted sum of factor scores for the plan along the four dimensions. This evaluative measure was used because 1) The measure resulted in the same prediction as other more complicated techniques and 2) Other studies cited earlier had successfully used an unweighted sum of perceptions as a measure of over-all attitude toward a product. The population was then divided into three groups.

Group I included those in our sample who exhibited preference inertia each time they had an opportunity to. Recall that every respondent evaluated four health plans, including their present or existing system, and then ranked the four plans according to over-all preference. There were thus three comparisons between health innovations and existing care made by each respondent. If each time a particular respondent evaluated an innovation higher than existing, he/she still preferred existing over that innovation, the respondent was classified into Group I.

Group II included those who did not exhibit preference inertia any of the times they could have. That is, every time they evaluated an innovation higher than existing, they went ahead and preferred that innovation over existing.

Group III included two types of respondents. First were those who were inconsistent in manifesting preference inertia. For example, they might have evaluated two innovations higher than existing, and preferred one over existing, but not the other one. Second were those who evaluated all innovations lower than existing so did not have the opportunity to exhibit preference inertia.

The sample size for each group was then as follows:

Group I	Group II	Group III	Total
53	59	99	211

We now focus on determining what distinguishes Group I members from Group II

members. From this effort we hope to provide clues as to why Group I exhibited preference inertia while Group II did not. We thus look at differences between these groups along demographic and other attitudinal variables. Table II summarizes the results.

TABLE II

COMPARISON BETWEEN GROUPS ONE AND TWO: PREDISPOSITION FACTORS

Factor	Group I (Inertial)	Group II (Non-inertial)	Significance Level Of Difference
1. Personal Health; % ranked themselves "OK" or "Not so good".	19	8	.09
2. Personal Health; mean on 1-5 scale, 1 → healthy	1.8	1.5	.12
3. Family Health; % ranked worst in family "OK" or "Not so good".	29	14	.05
4. Family Health; mean on 1-5 scale, 1 → healthy	2.0	1.7	.05
5. Health Insurance; % believe it covers everyting, very adequate or satisfactory	73	53	.03
6. Health Insurance; mean on 1-5 scale, 1→covers everything.	2.9	3.4	.01
7. Present Care; % satisfied or better.	74	49	.01
8. Present Care; Mean on 1-5 scale, 1 → satisfied	3.2	3.7	.03
9. Health Costs; % pay $5-10/mo. for insurance.	40	25	.09
10. Health Costs; mean on 1-10 scale, 1→$5-10/mo 10→$50/mo.	2.0	2.4	.19
11. Utilization; % $\geq$ 12 dr. visits/year.	17	14	.66
12. Utilization; mean # doctor visits/year	8.6	7.5	.55
13. Age; % $\geq$ 45 years old.	26	12	.06
14. Age; mean age.	34	31	.25
15. % use private care for check-up.	48	40	.42

TABLE II (CONT.)

Factor	Group I (Inertial)	Group II (Non-inertial)	Significance Level Of Difference
16. % believe most people do not get good care.	13	43	.00
17. % $\geq$ 5 years in MIT community.	36	47	.23
18. % male.	75	86	.14
19. % students.	45	55	.29
20. % staff.	36	24	.16
21. % faculty.	19	22	.66
22. % married.	45	36	.32

The information included in the table allows us to conclude some fundamental differences between Groups I and II. We can derive the following profile of inertial prone respondents in comparison with non-inertial prone respondents;

1. Relatively unhealthy with less healthy families.
2. Happier with current health care and higher respect for health system as a whole.
3. Currently paying less out-of-pocket for health insurance.
4. Slightly higher consumption in terms of doctor visits.
5. Tendency to be older, married, more likely to be female.

Since they see themselves as less healthy, inertia prone people probably depend more on their existing services for maintaining their healt. There is thus more at stake for them in switching to a new health plan that might not deliver all it promises. Since they are already happy with their present care, they have little impetus to prefer a new health plan even if it is better on paper. It is interesting to note that inertial prone respondents do not consume much more health services in terms of doctor visits, but given their state of health and their satisfaction with existing care, one may make a conjecture that their visits require more intensive care and took more time. The fact that inertial prone consumers are older, married, and not paying as much out-of-pocket for health insurance also suggests why they might be more conservative in switching preferences to a new

health plan.

Measurement;

Our objective now was to incorporate the concept of preference inertia into a model of consumer response. We will essentially define a new variable that measures the degree to which consumers exhibit preference inertia. This measure may vary across individuals or may be considered constant for the population. We develop models of the form;

$$(1) \qquad Pref_{ij} = f(\overline{PC}_{ij}, \Delta_{ij})$$

where $Pref_{ij}$ = Preference of individual i for alternative j.

$\overline{PC}_{ij}$ = Vector of attribute ratings of alternative j by individual i.

Δ_{ij} = Measure of preference inertia exhibited by individual i toward alternative j.

As a simplest form of (1), we could use

$$(2) \qquad Pref_{ij} = \sum_k B_k PC_{ijk} + \Delta_j$$

where PC_{ijk} = Rating by individual i of alternative j along attribute k.

B_k = Importance weight for attribute k.

Δ_j = Inertia measure (constant across individuals)

In (2), Δ_j would equal zero for j indexing the existing health plan, and be non-zero otherwise. A negative Δ_j indicates preference inertia, since innovation j is thus handicapped by an amount Δ_j in comparison with existing. The B_k's and Δ_j's could be estimated statistically for example using regression or a logit formulation.

We might then assume that for j not indexing existing, the Δ_j are all equal. This model would hypothesize that the same degree of preference inertia is exhibited against all health innovations. If we allow Δ_j to vary across innovations, we would be hypothesizing that different innovations elicit different amounts of preference inertia.

As is formulated in equation (1), the preference inertia measure may be considered to vary across individuals. The question arises; how might such an idiosyncratic measure be derived? We will use discriminant analysis for this purpose. In particular, a discriminant function was developed to predict membership in Group I (inertial group) or Group II (non-inertial group). This discriminant function was used to derive probabilities of membership in the inertial group for the entire sample.[1]

Respondents with higher probability scores have a higher tendency to manifest preference inertia. We would likewise expect those with higher probability scores to exert more preference inertia toward an innovation than those with lower scores. In terms of our earlier profile of inertial-prone consumers, one who is extremely satisfied with his/her existing care would have more bias against an innovation than one who was merely satisfied. We thus propose using the probability of belonging to the preference inertia group as an idiosyncratic measure of inertia proneness.

Several step-wise discriminant analyses were made. The results of these runs were fairly consistent. The sample consisted of the 53 respondents from Group I and 59 from Group II. The best accuracy achieved in reclassifying this sample was 71% correctly reclassified. This is comparable with other studies classifying innovators versus non-innovators [16 18]. The classification matrix was significantly different from random at the .005 level. Seventeen independent variables were used, including those in Table II plus additional demographic variables such as traveling distance to MIT and years in the MIT community. Some of the variables were not interval scaled nor normally distributed, which casts doubt upon the reliability of the discriminant coefficients. However,

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1. This can be derived (see [16]) to be $\Pr(\text{individual i is from Group I} \mid Z_i) = 1/(1 + \exp(-Z_i))$ where Z_i = individual i's discriminant function score.

we were interested in classification probabilities, not the discriminatory powers of the independent variables. Since the discriminant function reclassified well, it was used to calculate the probability of being in the inertial group as an idiosyncratic inertia measure.

Models of the general form (2) were calibrated next. Regression was used and degrees of freedom were gained by estimating across individuals. Our modeling efforts fall into two major categories:

Category 1; Same inertia measure for all respondents;

Category 2; Idiosyncratic inertia measures derived from discriminant analysis. Table IV summarizes these models in brief.

TABLE IV

PREFERENCE INERTIA MODELS CALIBRATED

Category I - Some inertia measure across respondents.

1) $PREF_{ij} = B_1Q_{ij} + B_2P_{ij} + B_3V_{ij} + B_4C_{ij} + \Delta\delta_j$

2) $PREF_{ij} = \gamma[Q_{ij} + P_{ij} + V_{ij} + C_{ij}] + \Delta_H\delta_H + \Delta_{MIT}\delta_{MIT} + \Delta_{MHF}\delta_{MHF}$

Category II - Idiosyncratic inertia measures

1) $PREF_{ij} = B_1Q_{ij} + B_2P_{ij} + B_3V_{ij} + B_4C_{ij} + \Delta D_i\delta_j$

2) $PREF_{ij} = \gamma[Q_{ij} + P_{ij} + V_{ij} + C_{ij}] + \Delta_H\delta_H D_i + \Delta_{MIT}\delta_{MIT} D_i + \Delta_{MHF}\delta_{MHF} D_i$

$j=1 \rightarrow$ Existing, $j=2 \rightarrow$ HCHP, $j=3 \rightarrow$ MIT HMO, $j=4 \rightarrow$ MHF

$PREF_{ij}$ = Rank order preference, person i for plan j

Q_{ij} = Individual i's normalized factor score for Quality, plan j.

P_{ij} = Individual i's normalized factor score for personalness, plan j.

V_{ij} = Individual i's normalized factor score for value for plan j.

C_{ij} = Individual i's normalized factor score for convenience for plan j.

TABLE IV (cont.)

D_i = Individual i's probability of belonging in inertia group (from Discriminant Analysis)

$$\delta_j = \begin{cases} 0 & \text{if } j=1 \\ 1 & \text{otherwise} \end{cases} \qquad \delta_H = \begin{cases} 1 & \text{if } j=2 \\ 0 & \text{otherwise} \end{cases}$$

$$\delta_{MIT} = \begin{cases} 1 & \text{if } j=3 \\ 0 & \text{otherwise} \end{cases} \qquad \delta_{MHF} = \begin{cases} 1 & \text{if } j=4 \\ 0 & \text{otherwise} \end{cases}$$

B_1, B_2, B_3, B_4, Δ, γ, Δ_H, Δ_{MIT}, Δ_{MHF} are weights to be estimated by the regression.

Testing;

We now will investigate diagnostic and prediction capabilities of the models calibrated. We first examine the inertia coefficients Δ,Δ_H,Δ_{MIT}, and Δ_{MHF}. These coefficients are shown in Table V. The numbers reflect the relative importances of these parameters. Numbers in parentheses are t-statistics.

TABLE V

INERTIAL COEFFICIENTS DERIVED FROM REGRESSION

Category	Model	Δ	Δ_H	Δ_{MIT}	Δ_{MHF}
I	1	-.03(3.9)	-	-	-
I	2	-	-.13(8.5)	-.02(1.5)	-.09(6.3)
II	1	-.04(6.2)	-	-	-
II	2	-	-.16(7.4)	-.02(0.7)	-.13(6.1)

We note that HCHP and MHF elicit stronger inertial reactions than the MIT HMO. This is indeed a plausible result. Remember that respondents were from the MIT community. They would obviously be more receptive to a health facility provided by and located within their place of work or study. Our models say then that an

HMO at MIT has a head start over other possible health plans in luring the population away from their present pattern of care.

As an initial test of predictive ability, we will look at predicted preference share, first preference recovery, and diagonal recovery. Table VI records the results. Models in Category I over-predict existing share. The reason for this is that those models use an over-all preference inertia measure. This measure is too heavy-handed for the delicate task of predicting preference share. It assumes that each individual exhibits the same amount of preference inertia toward a given innovation.

TABLE VI

PREDICTION RESULTS OF INERTIAL MODELS

Category and Model	First Preference Recovery	Diagonal Recovery	Preference Share			
			E	HCHP	MIT	MHF
I-1	55%	50%	55%	10%	18%	16%
I-2	54	46	48	1	40	10
II-1	58	50	45	11	23	21
II-2	54	47	44	2	41	13
Actual	-	-	43	10	26	20

However, note Category II models all predict existing very well. Category II, model 1 has strong recovery and predicts preference share very well for all alternatives. This is a very encouraging result. Model 2 in Categories I and II do not do as well in predicting innovation share. The reason for this is probably model specification error. In particular, we have been interested primarily in existing preference share. Inclusion of an inertial measure that is constant across innovations compares each innovation to the existing product. However, there are actually a total of six comparisons being made. Three involve innovation-existing comparisons. Three involve inter-innovation comparisons. We have not been interested in these last three comparisons. Models with alternative-specific

inertial measures implicitly model this process. For example, out results would have us believe that if both Harvard and MIT are evaluated higher than existing, we will almost always prefer MIT because HCHP is handicapped in comparison with MIT by an amount $\Delta_H - \Delta_{MIT}$. This may not be realistic. Once an innovation overcomes a comparison with existing, it would probably be evaluated on equal terms with other innovations that have overcome preference inertia. In short, there is another question to be answered involving the comparison of innovations with each other. We have only been interested in modeling comparisons between innovations and existing. Category II, model 1, does an excellent job of this. Note that it treats innovations as equals once the inertial threshold is overcome. We then look at this model and compare it with the first regression model presented in Table I that did not include preference inertia. The question arises - why did the inertial model do so well? We compare importance coefficients between these two models:

TABLE VII

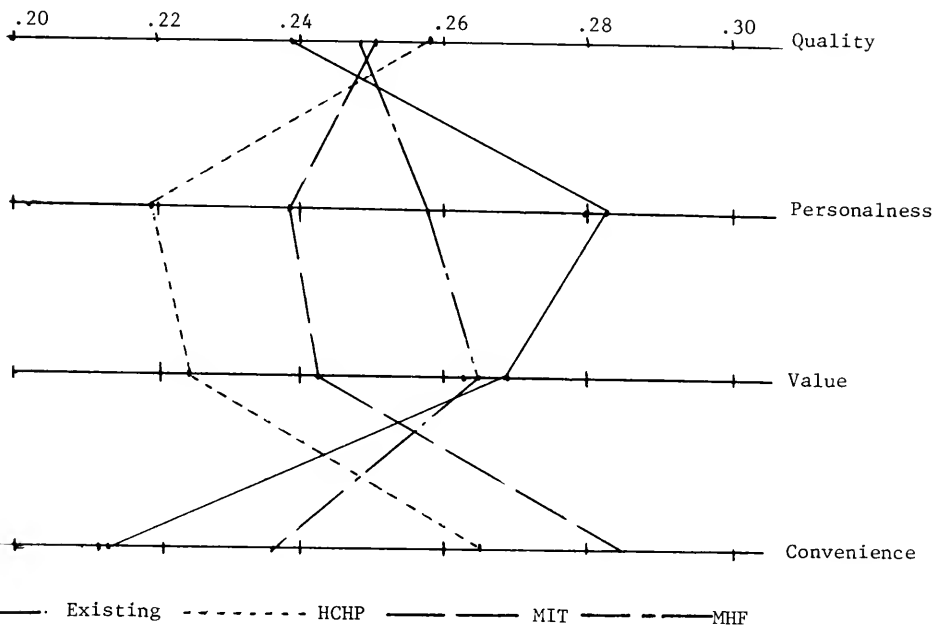
RELATIVE IMPORTANCE WEIGHTS - INERTIAL AND NON-INERTIAL MODELS

	Non-inertial	Inertial
Quality	.33 (.2709)	.33 (.2749)
Personalness	.20 (.1908)	.15 (.1451)
Value	.30 (.3602)	.27 (.3358)
Convenience	.18 (.1783)	.21 (.2141)
Inertial Coefficient (Δ)	-	-.04 (-.1905)

The weights in parentheses are standardized weights, obtained by multiplying original raw weights times the standard deviation of the independent variable in question (e.g. quality) and dividing by the standard deviation of the dependent variable (preference). To enhance our interpretation of these results, Figure 1 is provided. Figure 1 is a perceptual map of the four health plans. Plotted are

means for each plan along each dimension. Scores are normalized for each individual across plans, hence if each plan was rated exactly the same by a given individual along the same dimension, each plan would have a factor score equal to .25. For assessing the significance of differences between points, one can conservatively use .007 as the standard deviation for each difference.

FIGURE 1: AVERAGE FACTOR SCORES



The differences between importance weights for the two models are not very substantial. Quality has almost exactly the same importance. For the inertial model, lower weights for personalness and value take away preference share from Existing and MHF, while increased emphasis on convenience adds preference share to MIT. (See Figure 1) The inertial parameter balances existing's lost share by handicapping each innovation by D_i. The net result is correct prediction of preference share. We repeat the preference share predicted by both models:

	E	HCHP	MIT	MHF
Non-inertial Model	26%	15%	26%	33%
Inertial Model	45%	11%	23%	21%
Actual	43%	10%	26%	20%

As a final test of the inertial model, a saved data test was undertaken. Both discriminant analysis and regression had been used to calibrate the model. Such techniques can be highly manipulative and thus a prudent procedure is to test the model on an independent data sample. A sample of 50 from the original data base had been set aside and not used to calibrate any of our models. We now test the inertial and non-inertial models on this data base. The results are quite informative, and substantiate the validity of the inertial model.

TABLE VIII

SAVED DATA TEST

Model	First Preference Recovery	Predicted Preference Share			
		E	HCHP	MIT	MHF
Non-inertial	36%	26%	9%	35%	30%
Inertial	54%	38%	7%	25	30
Actual	-	42	10	24	24

As a result of our testing procedures, we can conclude that our individual-specific inertial model does very well in providing diagnostics, prediction, and prediction on saved data. This section also verified that other models, especially those of Category I, are not as successful in recovering preference share. Models with alternative specific inertia measures are adequate for predicting existing but fall down in comparing innovations with each other.

DISCUSSION OF RESULTS

The basic tenent of this research is that it can be advantageous to incorporate a behavioral phenomenon into analysis of consumer response to new products and services. In particular, this research has presented and analyzed the concept of preference inertia. The concept is that consumers can be expected to exhibit a certain obstinacy or conservativeness in preferring innovations to an existing product, although the innovations may be evaluated higher.

Our first goal was to explain preference inertia in terms of demographic, consumption, and general attitudinal variables. This was accomplished successively with pleasingly intuitive results. In view of our profile of non-preference inertia prone consumers as being healthier, younger, unmarried males, the MIT HMO might expect its first enrollees to be of that type. This would mean less demand initially for the HMO's services, which would be beneficial. Since the HMO is a prepaid service, the initial dearth of demand would allow the organization to iron out any start-up difficulties.

Preference inertia was successfully included in a simple model of consumer response. Use of an individual measure of inertia-proneness derived from discriminant analysis provided the best prediction results, which held up under a saved data test. Other models derived alternative specific measures of inertia which produced the useful diagnostic that the MIT HMO evoked less preference inertia than two other health innovations, but these models were less impressive in terms of prediction. As a result, we would recommend to researchers interested in examining preference inertia that a few different models should be calibrated in analyzing the phenomenon. This assures one of developing rich diagnostics and a method of predicting changes in product design.

EXTENSIONS AND FURTHER RESEARCH

An obvious extension of this research would be to observe actual choice. One could then determine whether preference inertia is a precurser of "choice inertia". In observing actual behavior we could determine whether our characterization of those who do not exhibit preference inertia coincides with a description of health innovators.

We should also compare our results with utility theory. The concept of risk aversion may be similar to preference inertia in its consequences if not in its basic conceptualization. One could compare risk averseness of individuals with their propensities for preference inertia. We should note the differences between risk aversion and preference inertia. Risk aversion occurs along dimensions, while preference inertia is more of a risk aversion to change. Different programs can elicit different degrees of inertia. This can not happen with risk aversion, which affects two plans with equivalent dimensional ratings equally. Hauser and Urban [13] have recently completed a study in which utility functions were directly assessed for a random student sample from MIT in connection with the same study of HMO development for MIT. These utility functions predict preference share well. There is then a good opportunity to compare utility theory with preference inertia.

There is also more work to be done in modeling the consumer preference process. We noted that there are inter-innovation comparisons made that were not modeled since we were concerned with innovation-existing comparisons. Perhaps a two stage model involving comparisons to existing and then comparisons among innovations better than existing care is in order.

Finally, the applicability of preference inertia to other fields beside health should be investigated. We have formulated our ideas specifically with regard to health innovations. However, the concept of preference inertia need

not be limited only to the health area. Indeed, further studies in health and other areas will serve as the true test of this research.

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